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No. 154

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THE SUPERMARINE S.6.B. RACING SEAPLANE (BRITISH)

A Low-Wing Twin-Float Monoplane

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THE SUPERMARINE S.6.B. RACING SEAPLANE (BRITISH)\*

A Low-Wing Twin-Float Monoplane

The Supermarine S.6.B. seaplane, winner of the 1931 Schneider Trophy in the final contest, is a development of the S.6. 1929 racer.

Before giving a description of the improvements in the 1931 racer a brief outline\*\* of the S.6. follows:

The Supermarine S.6. is a low-wing monoplane, twin-float type, built entirely of metal, the type construction being a development of the S.5.

The wing surface radiators are a new development. They are made as a wing covering taking torsional loads and consist of two thicknesses of duralumin with a very thin waterway in between. They have a perfectly flat outer surface and add no resistance to the machine. This method of construction has saved a considerable amount of weight over previous seaplanes.

The fuselage is constructed of metal, the skin taking practically all the stresses. The skin of the engine mounting takes all the engine loads. In place of the cantilevered engine mounting used on the S.5. the front float struts have been moved forward to provide a support and a substantial saving in weight has thus been effected. The floats are constructed of duralumin with the exception of the central portion, which forms the fuel tank which is made of steel. The duralumin is anodically treated to resist sea-water corrosion.

The bracing wires are of special streamline section. Six of the wires at present in the seaplane are only fitted as an additional safeguard during trials and practice, and will be removed for speed trials and racing.

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\*From Aircraft Engineering, October, 1931.

\*\*Pamphlet issued by Supermarine Aviation Works, Ltd.

As a result of the experience with the 1929 aircraft, the following improvements\* were incorporated in the new 1931 aircraft, which are referred to as the S.6.B. type. (Figs. 1, 2, 3, 4, 5.)

(1) Oil system (figs. 6 and 7).— This is, as before, housed entirely in the fuselage. Oil when it leaves the engine is forced along the side coolers to the top of the fin tank. By an arrangement of ribs and gutters the oil is kept in contact with the shell as it falls to the normal level and passes through a filter into the return (suction) cooler which is built on the same lines as the side coolers, but of greater section. Oil cooling had to be improved considerably to cope with the increased horsepower, and it was found that difficulty lay not so much in the transferring of the heat from the cooler to the air as in the transferring of it from the oil to the surface of the cooler. Eventually, as a result of extensive research work, it was found possible to increase the efficiency of the coolers by as much as 40 per cent. This was done by sweating small vanes in the oilways, but a great deal of experiment was necessary before the type and pitch of vanes could be decided, because excessive restriction in the flow increased the pressure difference between inlet and outlet by an enormous amount. The gutters in the fin tank performed a similar duty and the capacity of the tank itself was much increased to carry the additional oil required. In actual practice, the temperature drop between oil outlet and oil inlet reached 60°C, a figure never before approached on any aircraft.

(2) Water system (fig. 8).— In order to keep the new engine at the correct temperature it was necessary to dissipate approximately 40,000 B.t.u. of heat per minute from cooling surfaces. The efficiency of the wing radiators could not be improved to any appreciable extent and therefore more surface had to be provided. The topsides of the floats were accordingly covered entirely with radiator instead of the usual shell plating, and with this addition, cooling was adequate. A new type of header tank with a steam separator was designed to prevent any loss of water, but in other respects the system was unaltered.

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\*This article was prepared by the design staff of Supermarine Aviation Works, Ltd., under the direction of Mr. R. J. Mitchell.

(3) Fuel system (fig. 9).— The fuel is carried inside the floats, and is delivered to a small pressure tank in the fuselage by means of engine-driven pumps. The engine is fed from this pressure tank. The fuel pumps cease to function on a steeply banked turn owing to the increased centrifugal loading when loads of five or six times gravity are experienced. The small pressure tank contains just sufficient fuel to keep the engine running during a turn, and is replenished when the pumps begin to work after the turn.

Considerably more fuel is carried in the starboard float than in the port float. This is arranged to balance the enormous engine torque, particularly at take-off. This effect is so important that it is doubtful if the seaplane could be taken off the water with a very light load of fuel as a result of the yawing effect produced by one float being loaded much more heavily than the other.

The effect of full engine torque is to transfer a load of about 500 pounds from one float to the other.

In the early stages a good deal of trouble was caused by the transfer of the fuel from one float to the other, leaving one tank nearly empty while the other remained full, but this difficulty was in due course overcome by a special venting system in the overflow pipes from the header tank.

(4) Floats.— Extensive tests have been carried out on models both in the Vickers Experimental Tank at St. Albans, and in the wind tunnel at the National Physical Laboratory, to produce a form of float to satisfy aerodynamic and hydrodynamic requirements, in the most efficient manner. It has been found possible to reduce appreciably the air resistance per unit volume, and at the same time improve the take-off characteristics when compared with the 1929 floats, both by reducing hump resistance and by increasing stability.

The method of construction of the new floats presented considerable difficulty owing to the fitting of water cooling radiators on the whole of the upper surface. The radiators expand nearly half an inch when filled with the cooling water at nearly boiling temperatures, and to prevent buckling of the skin an elastic framework construction had to be devised to take up the necessary expansion.

(5) Control.--The mass balances fitted to the ailerons and rudder were incorporated with a view to obviating any possibility of flutter developing. (Figs. 2 and 4.) On the S.5.s., slight aileron flutter was experienced if the controls were allowed to get slack. Calculations showed that at the increased speed of the S.6.B.s there was a possibility of trouble in this respect, and the mass balances were therefore fitted as a precautionary measure. When travelling at maximum speed, the ordinary small inaccuracies of construction make themselves felt by producing air loads upon the fin and stabilizer which necessitate loads upon the control column and rudder bar to correct. Since the tail unit is built into the fuselage, no change in rigging is possible. The elevators and rudder were therefore provided with small flaps on their trailing edges which were adjusted to the angle necessary to trim hands and feet off at top speed. These flaps were only a few square inches in area, but proved extremely effective in use. A curious point in connection with control on water was experienced this year. The new propellers were of 8 ft. 6 in. diameter, as compared with 9 ft. 6 in. for the 1929 aircraft, both types being designed by the Fairey Aviation Co. It was found impossible to take off with these new propellers owing to the fact that at an early stage in the take-off the seaplane swung violently to port even with full starboard rudder. It was, however, found that with the old 9 ft. 6 in. propellers the take-off was easy, and in fact, a great improvement on the S.6.A.s, owing to improved float design. Eventually, 9 ft. 1½ in. propellers were found to give satisfactory take-off, while with an 8 ft. 10 in. propeller, it was only just possible to get off under very favorable conditions.

## Characteristics of the S.S.B. Monoplane\*

Span	30 ft.
Chord	5 ft. 8 in.
Length over-all	27 ft. 9 in.
Height	12 ft.
Wing area	145 sq.ft.
Weight empty	4,560 lb.
Pilot	160 lb.
Fuel (135 gal.)	1,125 lb.
Oil (15 gal.)	150 lb.
Weight fully loaded	5,995 lb.
Wing loading	41.3 lb./sq.ft.
Power loading	2.6 lb./hp
Engine weight	1,630 lb.
Propeller weight	232 lb.

The 1931 R engine (fig. 10) used in this seaplane is a water-cooled twin-six type, developed from the 1929 racing engine (fig. 11) and from the standard 825 hp Buzzard (H) engine (fig. 12). The bore and stroke are 6 and 6.6 in., respectively, as in the Buzzard.

## The Supercharger

The most apparent difference between the racing engine and the standard one lies in the superchargers. This is necessitated by the enormous volume of air drawn in by the racing superchargers. To avoid a very large diameter unit, air is taken into the rotor at both sides. The position of the air intake in the racing seaplanes

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\*From The Aeroplane, September 30, 1931.

has been chosen as in the V of the engine, to avoid the ingress of spray, and necessitating the sheet-metal air duct at the rear of the engine. This duct is utilized to compress the air a little before it reaches the carburetor, and is retarded by the divergence of the duct before entering the carburetor. The reduction in kinetic energy produces a gain in pressure energy. This type of intake is now in use on many service airplanes.

The propeller reduction gear, of the straight-spur type is modified from the standard unit to conform with the airplane builder's requirements as to the shape of the nose. The camshaft and rocker covers are modified for fairing purposes. Beneath the engine the auxiliaries are raised a little on the racing engines to reduce the depth of fuselage required.

The 1929 racing engine produced 1,900 hp at 2,900 r.p.m. and weighed 1,530 pounds. The 1931 engine yields 2,300 b.hp at 3,200 r.p.m. and weighs 1,630 pounds. The power increase this year is 21 per cent for a weight increase of  $6\frac{1}{2}$  per cent.

To obtain the 1931 performance, it was decided to raise the engine speed, raise the supercharger gear ratio, and increase the size of the air intake. The approximate power and speed were decided upon before commencing the development work to attain this performance combined with the necessary degree of reliability.





Fig.1 Bringing out the S.6.B. on morning of Schneider contest.  
Calshot, Sept. 13, 1931.

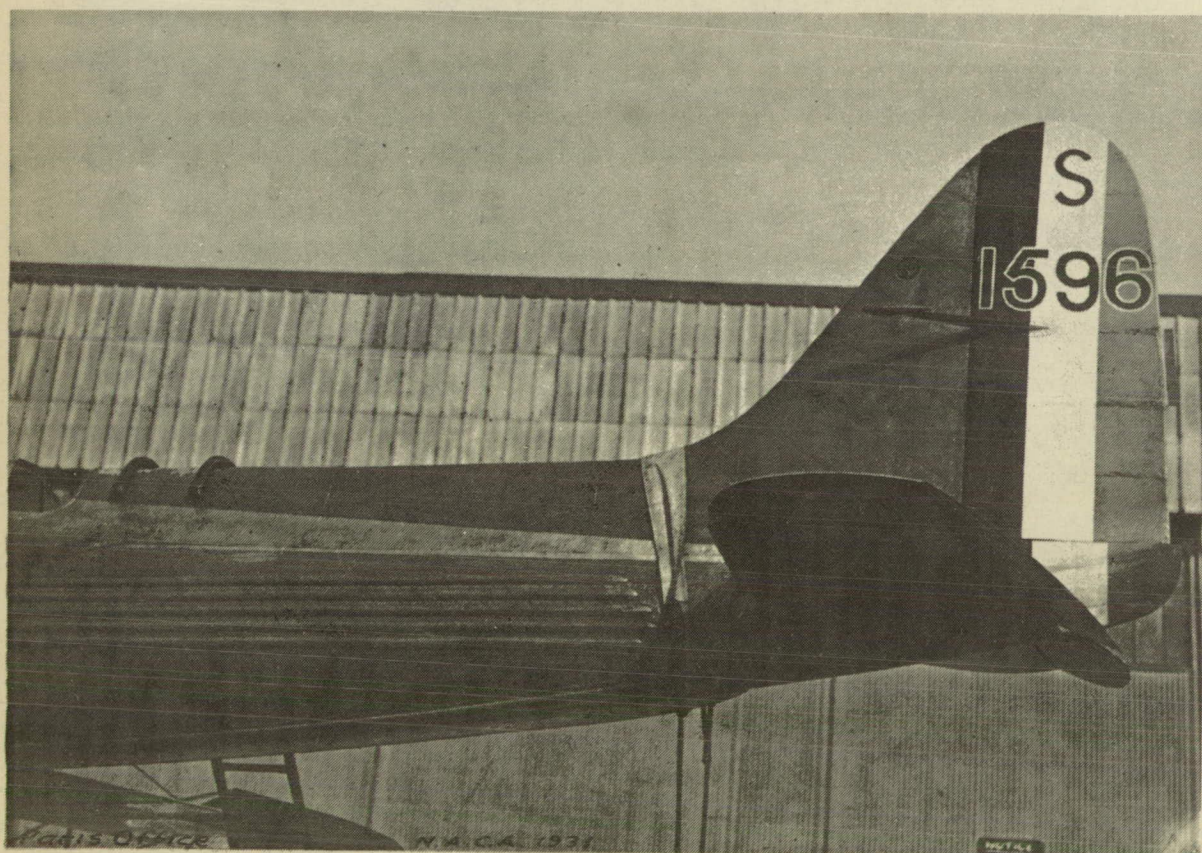


Fig.2 S.6.B. tail showing static balance on rudder and small trimming surface attached to rudder a few days before contest. Small circle on fin (near top) is oil intake. Elevators have edging serving as trimming device.



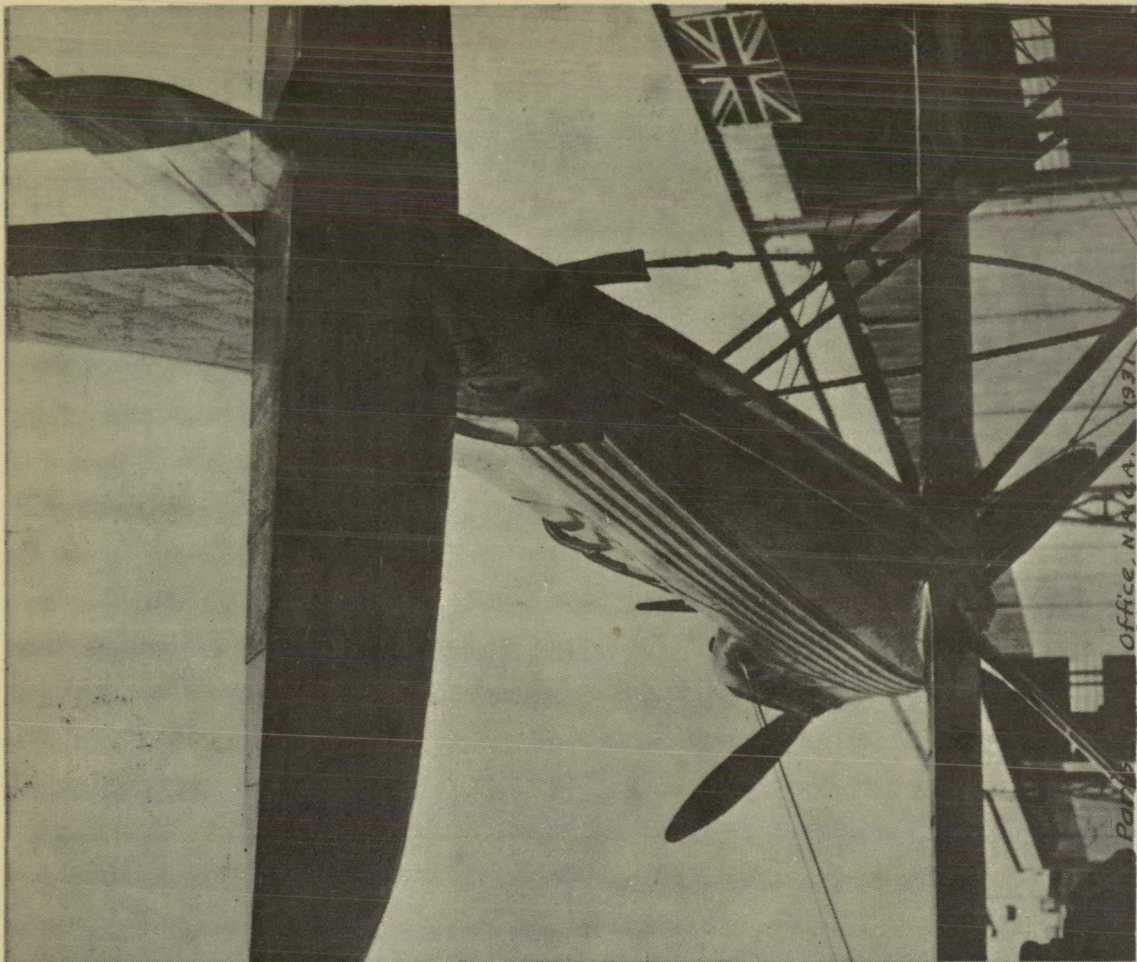


Fig.3 S.6.B. (S 1596) view from rear showing extreme narrowness of fuselage and junctions of float struts with fuselage.

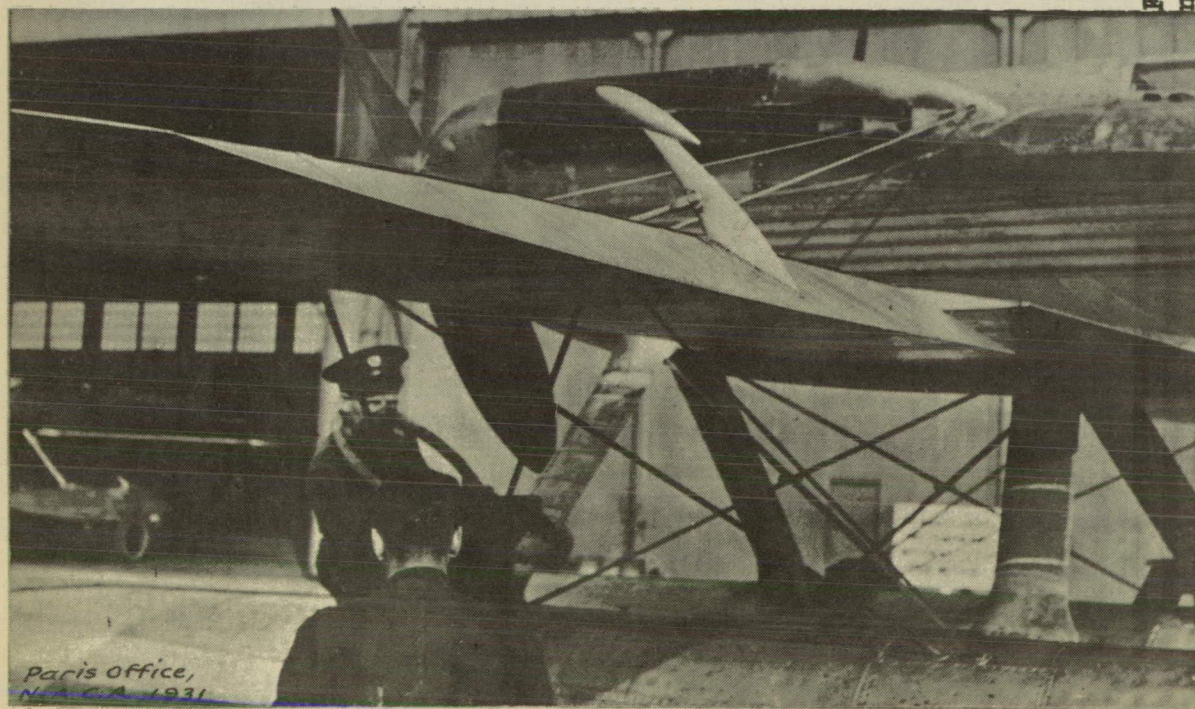


Fig.4 S.6.B. (S 1596) showing static balance of aileron.



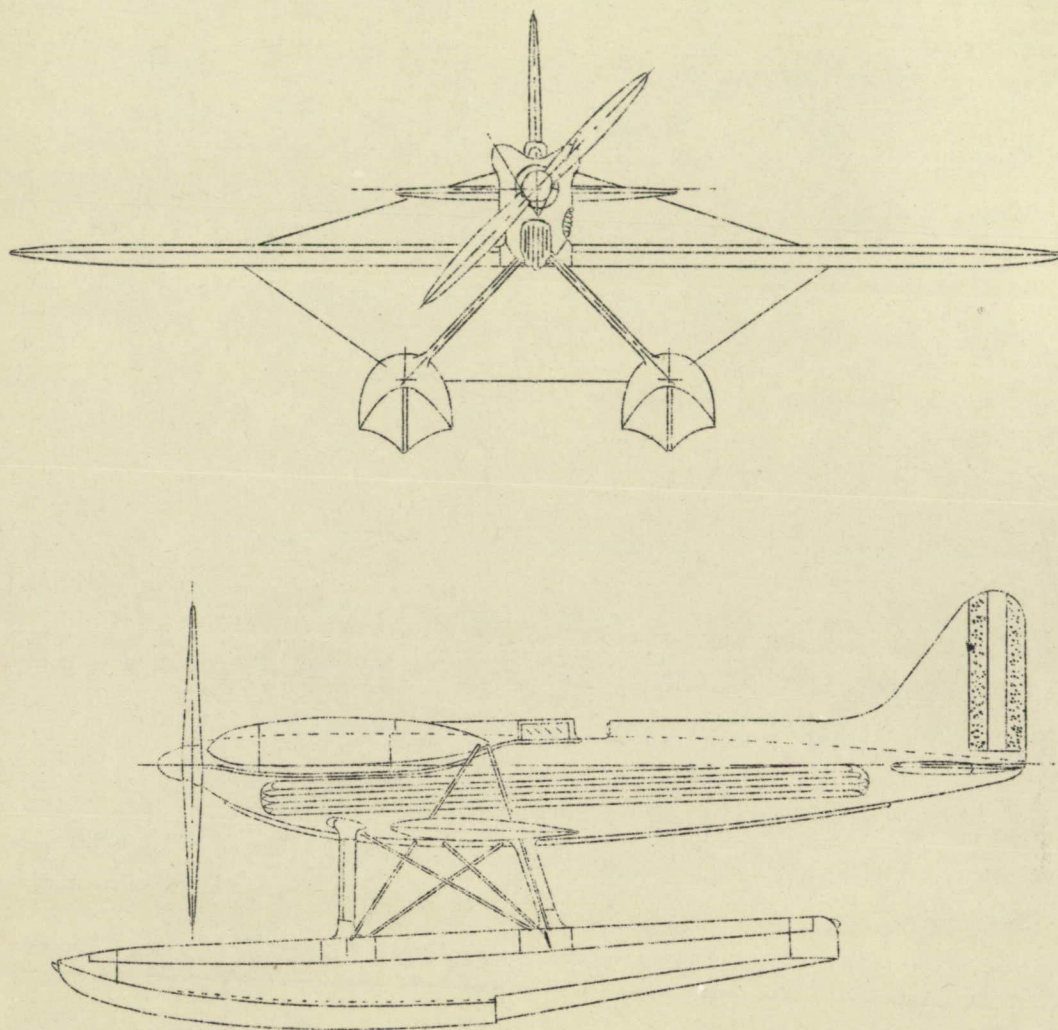
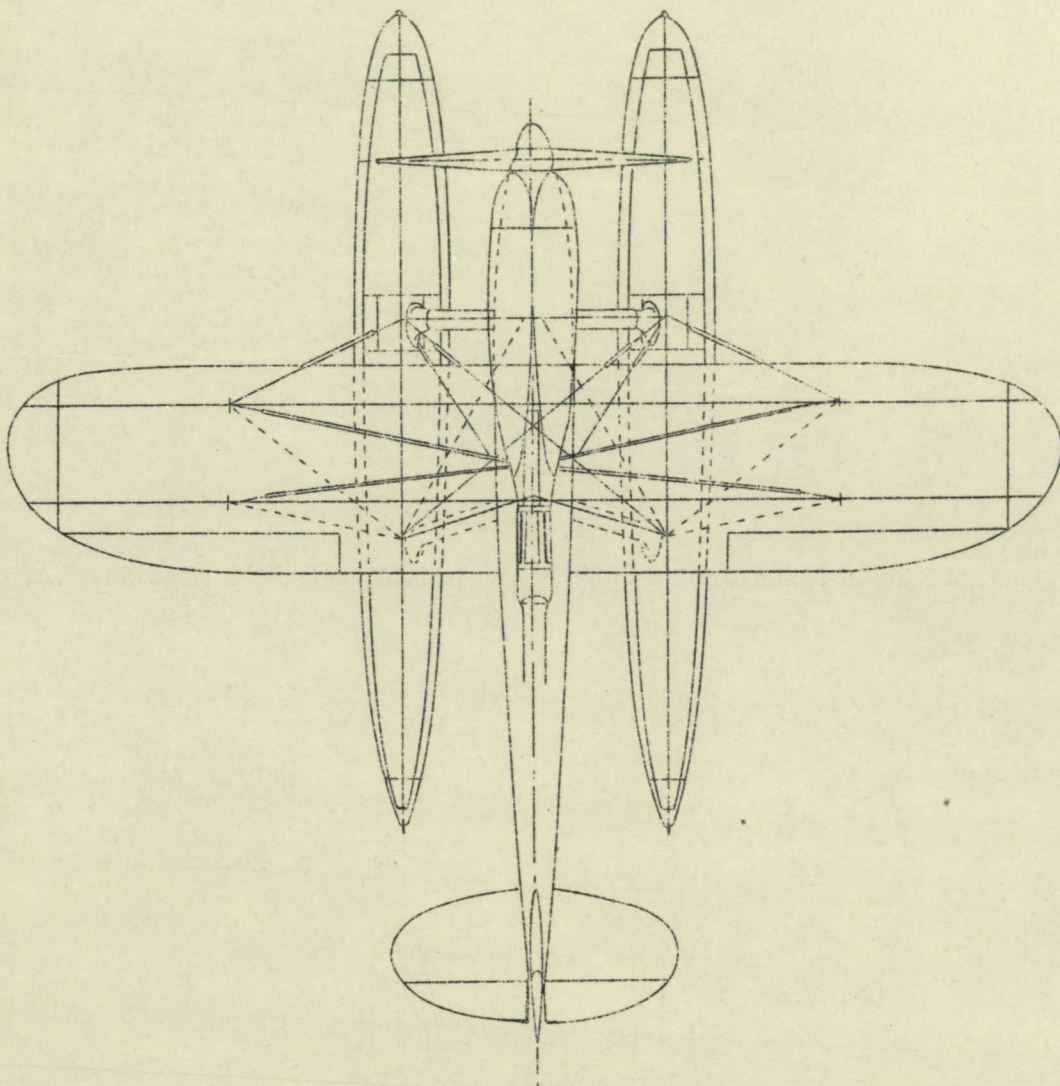


Fig.5 Front and side elevations of the Supermarine S.6. B. Schneider  
Trophy seaplane.  
(Continued on next page.)



(Fig.5 Continued) Plan drawing of the Supermarine S.6.B. Schneider Trophy seaplane.



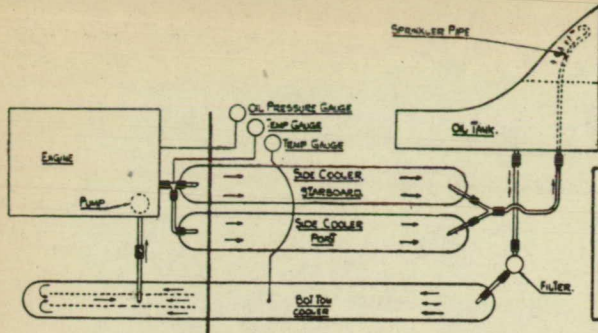


Fig.6 Diagram of oil system.

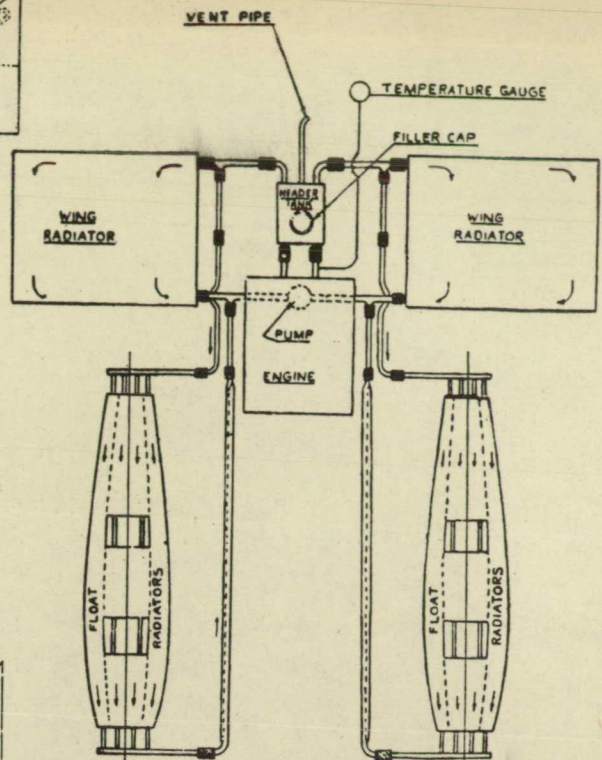


Fig.8 Diagram of water system.

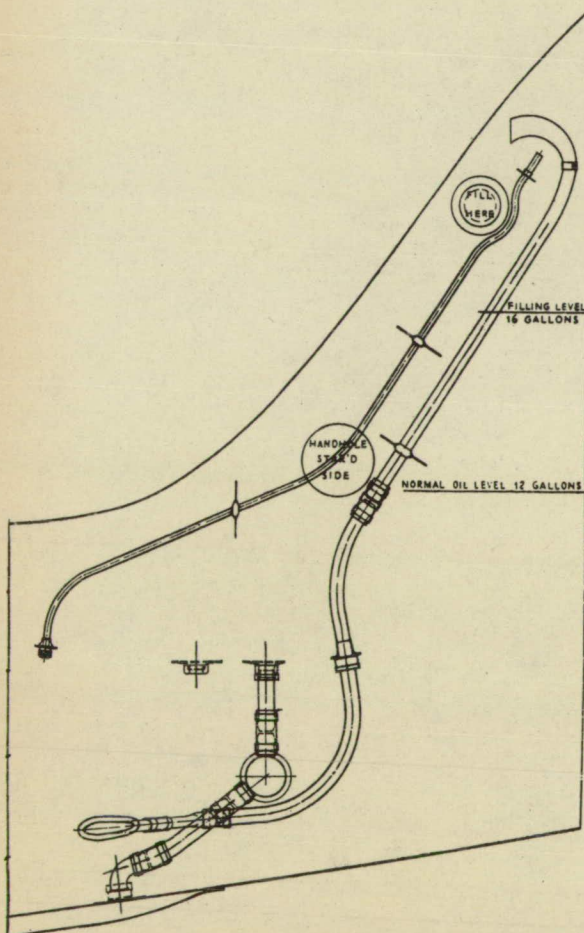


Fig.7 Oil cooling system in the fin.

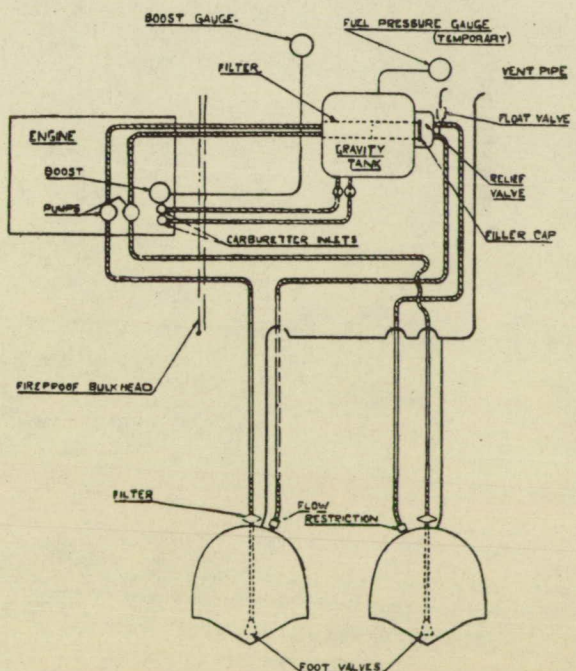
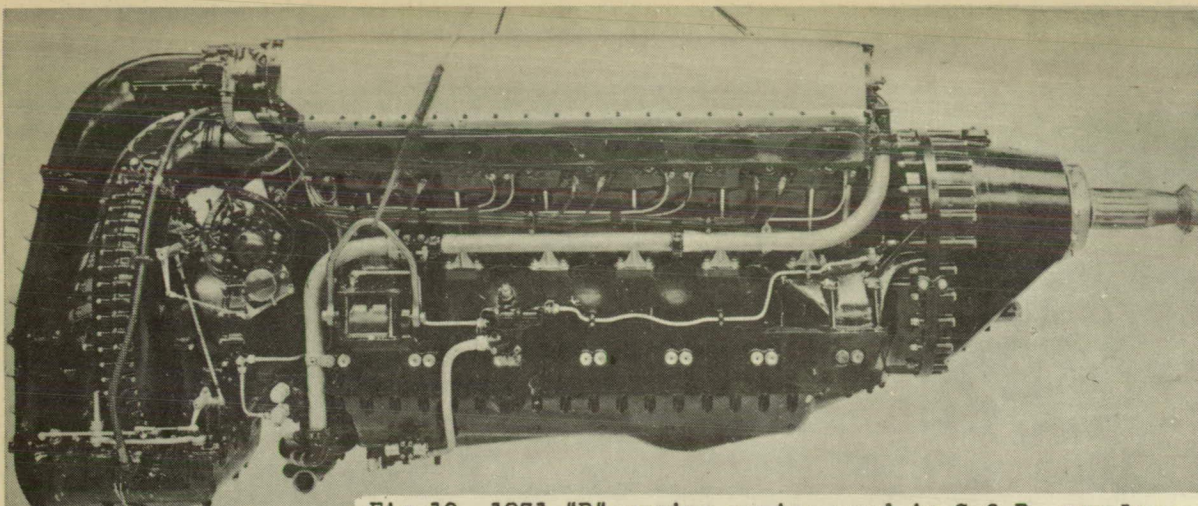


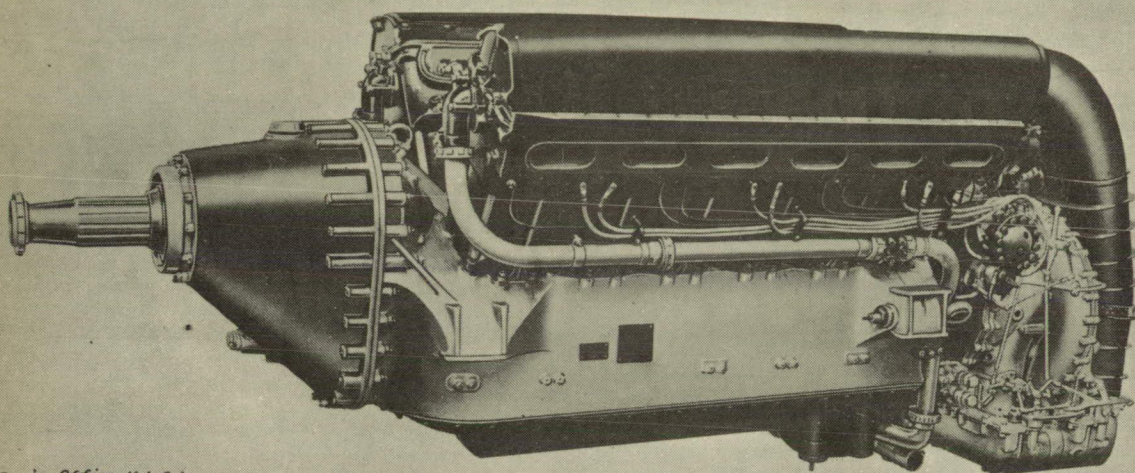
Fig.9 Diagram of fuel system.





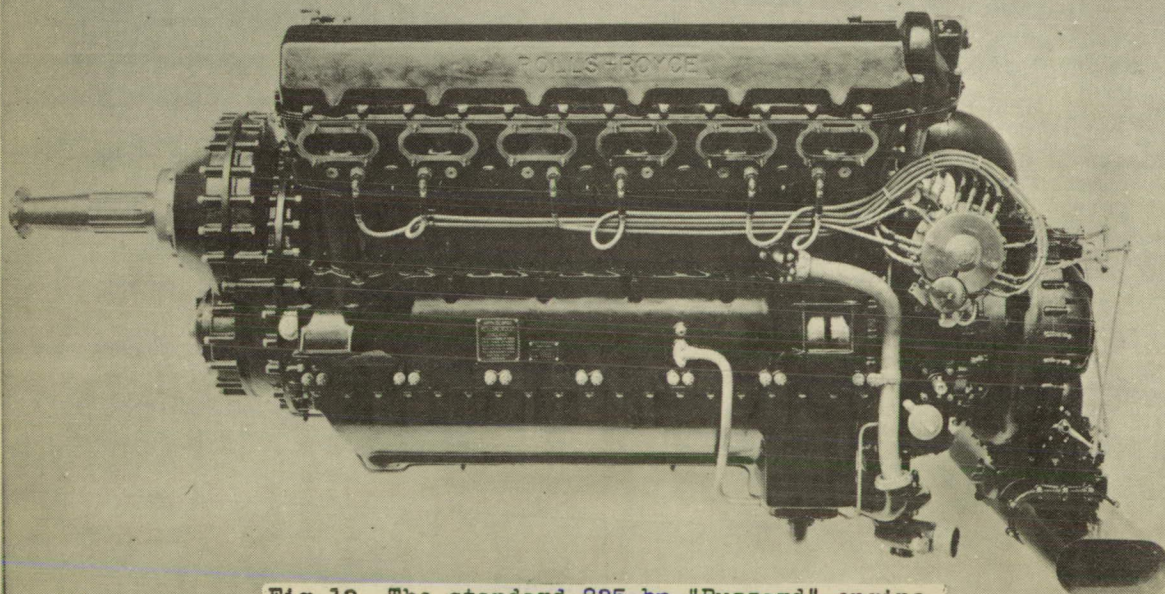
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Fig.10 1931 "R" racing engine used in S.6.B. seaplane.



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Fig.11 Rolls-Royce R engine used in 1929 race.



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Fig.12 The standard 825 hp "Buzzard" engine.